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ScienceDirect

Procedia Social and Behavioral Sciences 15 (2011) 3382–3589

Procedia Social and Behavioral Sciences

WCES-2011

Assessment of concept cartoons: an exemplary study on scoring

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Abstract

The present study on the use of concept cartoons for assessment purposes aimed to present exemplary applications about developing a concept cartoon test, planning for a scoring key and the analysis process. For this purpose, a concept cartoon test was developed including six concept cartoon questions about photosynthesis and respiration in plants. This test was applied to 192 science and technology teacher candidates in the 2009-2010 academic years. The data obtained from the study were analyzed using a scoring key developed by the researchers. Moreover, the study attempted to explain how the scoring key is used through examples about the analysis process and scoring criteria. The study results suggest that the scoring key developed by the researchers can be used in the assessment process for concept cartoons.
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Keywords: Concept cartoon, scoring key, assessment-evaluation, photosynthesis-respiration in plants, teacher candidate;

1. Introduction

It has been observed that the constructivist approach, where teacher adapts the role of a guide and students generate new knowledge using their previous experience, was applied starting with the new academic curriculum; implemented in Turkey gradually since the 2005-2006 academic year. The constructivist learning environments are quite different than the classroom settings based on the conventional teaching approaches (Kaya & Tüfekçi, 2008), and learning emerges from these settings, not through accumulation of knowledge or the memorizing of it, but through a process of thinking and analyzing (Karadağ, Deniz, Korkmaz & Deniz, 2008). In this respect, constructivism is an approach that is student-centered during the learning process (Arslan, 2007). Moreover, as stated by Özmen (2004) constructivism is based on the fact that the student constructs the newly acquired knowledge in his/her mind, comparing them with the previously acquired ones and thus s/he can give a meaning to the world around her/him. In parallel with the changes taking place in learning environments thanks to the constructivist approach, it is also seen that there have been some changes in the assessment and evaluation approach which is mainly used establish the extent to which the students have learnt the subject. Kanatlı (2008) stated that each new approach in the field of education affects the assessment and evaluation techniques while also affecting the methods used. While the purpose in traditional assessment and evaluation is to classify the students generally, based on their possessing certain characteristics, the purpose in using the alternative assessment evaluation techniques, suitable for the constructivist learning approach, is said to be to determine where the students are in the

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doi:10.1016/j.sbspro.2011.04.339

process of learning (Şenel-Çoruhlu, Er-Nas & Çepni, 2009). As indicated by Birgin & Baki (2009), in the constructivist approach, it is convenient to use various alternative assessment tools and technologies such as presentations, diaries, check lists, group work, observation, self-peer assessment, rubrics, performance assessment, projects and portfolios. One of the visual tools used as an alternative assessment technique with the constructivist approach is the concept cartoons put forth by Brenda Keogh and Stuart Naylor in 1992.

Concept cartoons are the visual tools composed of caricature drawings that encourage learners to engage in discussions by presenting, through the characters, alternative ideas about a scientific condition (Keogh, Naylor & Wilson, 1998). These visual tools are defined by Ekici, Ekici & Aydın (2007) as the illustrations of dialogues with three or more characters. İngeç, Yıldız & Ünlü (2006) define the concept cartoons as the use of a group of characters having a conversation and with this tool, the discussions and allegations among the characters are written as minimum texts. In concept cartoons, diverse perspectives of the characters regarding the daily events of the scientific concept are presented equally, and these thoughts generally involve the individual's mistakes and mistaken viewpoints about physical phenomenon, principle or conditions (Uğurel & Moralı, 2006). In any case, as stated by Baysarı (2007), concept cartoons are made up of characters reflecting the different perspectives regarding events and encouraging students to discuss the science subjects of daily life. As understood, concept cartoons are visual tools composed of three or more characters' suggesting ideas, discussing or thinking about a subject, an incident or a concept in daily life.

In literature there are studies on using concept cartoons (İngeç, Güzel & Karakaya, 2008) in different stages of the lesson and for different purposes, which were developed as an alternative strategy in order to clarify the relationship between the constructivist learning model and its epistemology and classroom practices. As seen in the studies of Keogh & Naylor (1999) and Kabapınar (2005), concept cartoons can be used for learning – teaching purposes during instruction. Additionally, teachers can benefit from the concept cartoons for such purposes as creating a discussion atmosphere (Naylor, Keogh & Downing, 2001; Balım, İnel, Evrekli & Kesercioğlu, 2008) and helping students ask their own questions (Long & Marson, 2003). According to Kabapınar (2009), concept cartoons can encourage students to develop scientific ideas and question within the learning-teaching process. Moreover, they can be used for revealing students' preliminary information (İnel, Balım & Evrekli, 2009) and detecting any misconceptions and/or eliminating them (Uğurel & Morali, 2006; Akdeniz & Atasoy, 2006; İngeç, Yıldız & Ünlü, 2006; Durmaz, 2007; Ekici, Ekici & Aydın, 2007; Yıldız, 2008; Özyılmaz-Akamca, Ellez & Hamurcu, 2009). Also, according to Birişçi, Metin & Karakaş (2010), concept cartoons ensure that the instruction process becomes more exciting and interesting.

While being used for different purposes in learning-teaching settings, concept cartoons can also be used as an alternative assessment-evaluation tool (Keogh, Naylor, de Boo & Feasey, 1999; Naylor & Keogh, 2007; İngeç, 2008; Song, Heo, Krumenaker & Tippins, 2008; Şaşmaz-Ören, 2009). According to Stephenson & Warwick (2002), concept cartoons can be utilized generally for formative assessment and, in this case, students can find out where their learning comes from by looking back. Moreover, these tools provide opportunities for feedback in the classroom against alternative ideas throughout the learning process and give information regarding how student ideas have changed (Dabell, 2008). In this respect, making use of concept cartoons for assessment purposes and student self-evaluation is said to be essential for encouraging students to be responsible for their learning and for following–up changes in their development. As is already known, concept cartoons were first presented by Keogh and Naylor as an alternative assessment tool within the context of learning-teaching approaches based on constructivism (Korkmaz, 2004). At this point, considering the aim of concept cartoons and the benefits for students, it is thought that studies regarding the utilization of these visual tools for assessment purposes are significant in terms of literature. Furthermore, although it is stated in literature that concept cartoons can be used as an assessment and evaluation tool, it can be implied that there aren't enough studies regarding using them for assessment purposes and developing a scoring key in line with this purpose. In this respect, this study aims at assessing concept cartoons and presenting examples regarding this assessment. In line with this purpose, the study includes the practice examples about the formation of the concept cartoons test, planning the scoring key and the analysis process.

2. Method

The method section of the study is given in three stages: 'developing concept cartoons test', 'implementation' and 'analysis of the concept cartoons test'.

2.1. Developing the concept cartoons test

In this study, conducted for the purpose of assessing concept cartoons, a concept cartoons test on the issue of photosynthesis and respiration in plants was developed. In the first stages of test development studies were made about photosynthesis and respiration in plants were examined. The test was prepared based on literature and the curriculum of the General Biology Lab II course, which is on the Science Education department 2nd grade course list. In order to determine the validity of the test, expert opinions were sought about the questions in the test, both in terms of content and its compliance with the rules of developing concept cartoons. While some of the questions remained the same, the content of some others were corrected and some questions from the 'association with daily life' section were regenerated in line with the expert opinions. Also, some of the questions were altered in terms of the characters they involve. Finally, the photosynthesis and respiration in plants test developed was applied to three students studying in the science education department, in order to detect the level of comprehension. Based on the feedback from these students, necessary changes were made and the latest version of the concept cartoons test was obtained. The concept cartoons in the test were composed of two main parts. The first part includes the item root regarding the question, concept cartoons and options where the names of the characters were written; the second part involves a section where the reason for the answer is explained. In the study, the answers given by the students in the first and second parts were analyzed, based on the scoring key developed, and explained by giving an example regarding each assessment criteria.

2.2. Implementation

The concept cartoons test developed on the issues of photosynthesis and respiration in plants was applied to 192 science and technology teacher candidates studying different grades in the spring term of the 2009 – 2010 academic year. Teacher candidates in the study group were studying in Celal Bayar University Faculty of Education, located in the Aegean region of Turkey. One hundred and twelve of these teacher candidates were second grade students, 34 were third grade and 46 were fourth grade. One hundred and twelve of the participants were female and 80 were male.

2.3. Analysis of the concept cartoons test

The first and second parts of six concept cartoons questions in the test prepared on the issue of photosynthesis and respiration in plants were analyzed together. The scoring key designed by Ormancı & Şaşmaz-Ören (2010) was used during the analysis process, which is demonstrated in Table 1 below.

Table 1. The Scoring Key used in the analysis of concept cartoons

Assessment Criteria	Score	Score Percentage (%)	Scoring Criteria
Correct Answer – Correct Explanation	3	100	* Correct Explanation: Explanation where the answer is implied with all scientific aspects * Partially Correct Explanation: Explanation where the answer is not implied with all scientific aspects or which involves some misconceptions * Wrong Explanation: (1) The answer is scientifically totally wrong, (2) is irrelevant, (3) is repeated as a whole, (4) is completely composed of misconception, (5) left as blank
Correct Answer – Partially Correct Explanation	2	67	
Wrong Answer - Correct Explanation	2	67	
Correct Answer – Wrong Explanation	1	34	
Wrong Answer – Partially Correct Explanation	1	34	
Wrong Answer – Wrong Explanation	0	0	

As seen in Table 1, the assessment criteria used in the analysis of concept cartoons is composed of answers and explanations parts; the first part of the test is the answer part and the second is composed of explanations. While

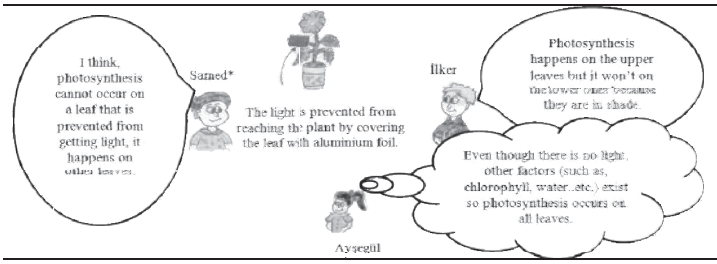
developing the scoring key, the explanation part is given more importance and scores regarding this part were kept higher. This is because the students may answer the first part of the cartoons with an artificial level of knowledge or memorized knowledge or because of the possibility that they may answer them haphazardly or by guessing. As well as this, in order for the students to fill in the second part of the concept cartoons, in other words the explanation part, it is thought that they should have the sufficient level of knowledge regarding the subject. Moreover, as seen in the table, the scoring key of the concept cartoons is composed of the 0-1-2-3 scores, and these scores can be converted into percentages. In the study, the analysis of the concept cartoons was performed by two researchers and the percentages of agreement for each question in the test were calculated. While calculating the percentage agreement, the 'percent agreement' formula developed by Miles and Huberman (1994) was used. The percent agreement was found to be 0.97 for the first question of concept cartoons test, 0.95 for the second, 0.93 for the third, 0.97 for the fourth, 0.88 for the fifth, 0.92 for the sixth and 0.94 for all questions in total.

3. Findings

In this section, data regarding the analysis of concept cartoons developed in order to determine Science and Technology teacher candidates' levels of knowledge on the issue of photosynthesis and respiration in plants is given. In addition, this section contains examples about the implementation of a scoring key designed for the purpose of assessing the concept cartoons. Each of the six tables that show the answers of teacher candidates related to the issue reflects an example for each different assessment criteria *(correct answer-correct explanation, correct answer – partially correct explanation, wrong answer – correct explanation, correct answer – wrong explanation, wrong answer – partially correct explanation, wrong answer - wrong explanation).*

An example of a concept cartoons question discusses whether photosynthesis occurs on a pot plant's leaf, covered with aluminium foil, and the results of the analysis showing the participants' levels of knowledge regarding this question of the test were given in Table 2. This table demonstrates one of the assessment criteria, an example of *correct answer-correct explanation*, corresponding to '3 points'.

Table 2. Example of concept cartoons question regarding the assessment criteria 'correct answer-correct explanation' and results of the analysis



Which of the student(s) above do you agree with? Samed ☐ Ayşegül ☐ İlker ☐
Please explain why you think that way. "*Light is absolutely necessary for photosynthesis. Without light, photosynthesis cannot occur, even if all other conditions are fulfilled.*" → Correct answer-Correct explanation

Which of the student(s) above do you agree with? Samed ☐ Ayşegül ☐ İlker ☐
Please explain why you think that way. "*Light is needed for photosynthesis. It cannot be realized on leaves that do not take light. It can be realized on others.*" → Correct answer-Correct explanation

	0	1	1	2	2	3*
2nd Grade	4	5	2	8	7	86
3rd Grade	0	1	0	2	2	29
4th Grade	3	1	3	3	16	20
Total	7	7	5	13	25	135

In the concept cartoons, the character 'Samed', who states that photosynthesis can't happen since the leaf is prevented from getting light, has the correct answer. This question, which was answered correctly by most of the Science and Technology teacher candidates (f=135), involves the analysis example for '*correct answer–correct explanation'* in the assessment criteria of the scoring key. The answers of the teacher candidates, marking the correct answer 'Samed' and giving the correct explanation are as shown.

The example of concept cartoons question which includes three students discussing why too many plants shouldn't be kept in the room at night time and the analysis results of this question are given in Table 3. This table also includes the example corresponding to *correct answer – partially correct explanation assessment criteria*, in other words, '2 points'.

Table 3. Example of concept cartoons question regarding the assessment criteria 'correct answer-partially correct explanation' and results of the analysis

Which of the student(s) above do you agree with? Nuri ☐ Ummuhan ☐ Mehtap ☐ → Correct answer-Partially correct explanation
Please explain why you think that way. *"Plants respire during the night. They take O_2 and give CO_2."*

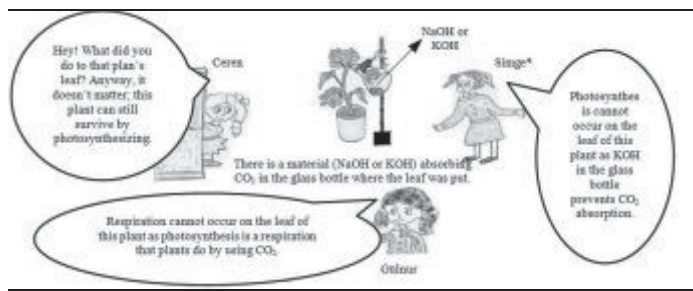
Which of the student(s) above do you agree with? Nuri ☐ Ummuhan ☐ Mehtap ☐ → Correct answer-Partially correct explanation
Please explain why you think that way. *"Plants cannot photosynthesize in the dark and at night. Light is necessary for photosynthesis."*

	0	1	1	2	2*	3
2nd Grade	3	1	3	2	39	64
3rd Grade	0	0	1	0	18	15
4th Grade	4	0	12	0	8	22
Total	7	1	16	2	65	101

As Ummuhan says, the reason why too many plants should not be kept in a room at night is because plants do not photosynthesize, they only respire. While 101 of the participants gave the correct answer and correct explanation, 65 of them, although they gave the correct answer, couldn't give the correct explanation. Next is an example of the analysis of two teacher candidate, who marked the correct answer (the Ummuhan character) but gave a partially correct explanation.

Table 4 shows the example of a concept cartoons question about how photosynthesis/respiration action will occur on a leaf that was put inside a glass bottle where there is a CO2 absorbing material, and analysis results regarding this question, as well as data about the participants' level of knowledge. This table is an example of *wrong answer – correct explanation* corresponding to '2 points' in the assessment criteria.

Table 4. Example of concept cartoons question regarding the assessment criteria 'wrong answer-correct explanation' and results of the analysis



Which of the student(s) above do you agree with? Ceren ☐ Gülnur ☐ Simge ☐ → Wrong answer-Correct explanation
Please explain why you think that way. *"Since materials such as NaOH and KOH have the absorbance property, there is yellowing on that leaf and photosynthesis cannot occur. It is realized on the others."*

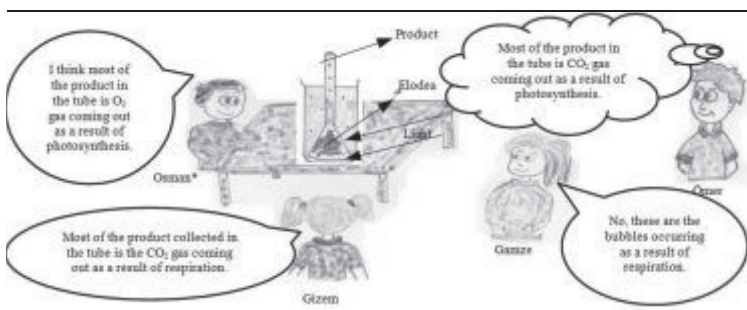
Which of the student(s) above do you agree with? Ceren ☐ Gülnur ☐ Simge ☐ → Wrong answer-Correct explanation
Please explain why you think that way. *"Leaves need CO_2 to photosynthesize. As the KOH material absorbs CO_2 well, it cannot photosynthesize. Only that leaf fails to do it."*

	0	1	1	2*	2	3
2nd Grade	12	13	0	35	4	48
3rd Grade	3	2	1	8	1	19
4th Grade	8	2	5	5	4	22
Total	23	17	6	48	9	89

In the concept cartoons, the 'Simge' character, who says that photosynthesis wouldn't occur since there is no CO_2 on the leaf in the glass bottle, makes up the correct option. The other two options, namely, 'Ceren' stating that the leaf would photosynthesize, and 'Gülnur' stating that the plant wouldn't respire as photosynthesis is the respiration that plants make by using CO_2 are the wrong choices. When the results of the analysis were examined, it was observed that 48 of the teacher candidates marked the wrong option but gave a correct explanation. Next, the answers of the two teacher candidates, who marked the wrong answer but gave a correct explanation, can be seen.

Table 5 demonstrates the example of concept cartoons where the product generated at the upper part of the tube in the testing apparatus prepared with the plant is discussed and the results of the analysis with regards to the participants' level of knowledge. This table shows the example corresponding to the assessment criteria *correct answer – wrong explanation* and '1 point'.

Table 5. Example of concept cartoons question regarding the assessment criteria 'correct answer-wrong explanation' and results of the analysis



	0	1	1*	2	2	3
2nd Grade	28	6	7	3	1	67
3rd Grade	7	0	4	0	0	23
4th Grade	13	0	12	1	3	17
Total	48	6	23	4	4	107

The 'Osman' character stating that the product collected at the upper part of the experiment tube prepared with an Elodea plant is the O_2 coming out as a result of photosynthesis is saying the correct answer. These concept cartoons were answered and explained

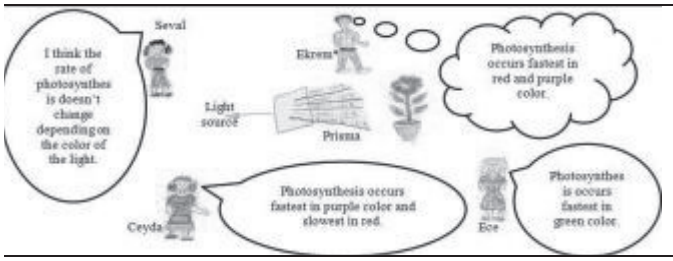
Which of the student(s) above do you agree with? Osman ☐ Gizem ☐ Gamze☐ Osman ☐ → Correct answer-Wrong explanation
Please explain why you think that way. "*Because Osman said the only correct one.*"

Which of the student(s) above do you agree with? Osman ☐ Gizem ☐ Gamze☐ Osman ☐ → Correct answer-Wrong explanation
Please explain why you think that way. "*Because gas formed as a result of respiration was compressed and formed bubbles.*"

correctly by 107 of the Science and Technology teacher candidates. Also 23 teacher candidates answered correctly but gave a wrong explanation. The answer of a teacher candidate who marked the correct Osman answer but had a wrong explanation is given.

Table 6 demonstrates the example of concept cartoons where the relationship between the color of light and rate of photosynthesis is discussed and the results of the analysis with regards to the participant's level of knowledge on the question. This table shows the example corresponding to the assessment criteria *wrong answer-partially correct explanation* and '1 point'.

Table 6. Example of concept cartoons question regarding the assessment criteria "wrong answer-partially correct explanation" and results of the analysis



Which of the student(s) above do you agree with? → Wrong answer-Partially correct explanation
Seval ☐ Ceyda ☐ Ece ☐ Ekrem ☐
Please explain why you think that with? *"The light with the highest wavelength is purple light. Therefore, leaves photosynthesize the fastest in purple light."*

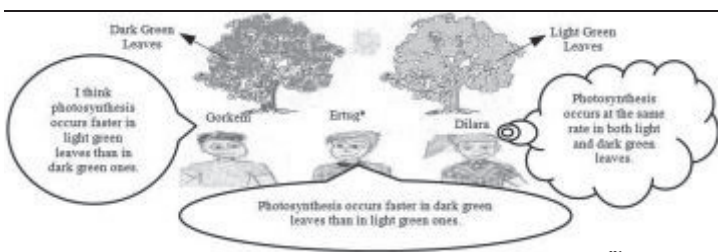
Which of the student(s) above do you agree with? → Wrong answer-Partially correct explanation
Seval ☐ Ceyda ☐ Ece ☐ Ekrem ☐
Please explain why you think that with? "*The color which has the fastest photosynthesis is certainly purple. Green cannot absorb light and its rate of photosynthesis is the slowest.*"

	0	1*	1	2	2	3
2nd Grade	21	48	4	1	25	13
3rd Grade	17	6	0	3	3	5
4th Grade	19	6	6	0	9	6
Total	57	60	10	4	37	24

The 'Ekrem' character, who says that the rate of photosynthesis is fastest in the red and purple colors, has the correct answer. However, the 'Ece' character, who states that photosynthesis occurs fastest in green color as well as the 'Ceyda' character saying that it is realized fastest in purple but slowest in red light and the 'Seval' character, who says that photosynthesis wouldn't change depending on the color of light are the wrong options. Although 60 of the participants marked the wrong choice in this question, they gave a partially correct explanation. The analysis examples implying this situation are given next.

Table 7 demonstrates the example of concept cartoons drawn regarding the relationship between the color of the leaf and the event of photosynthesis and the results of the analysis with regards to the participant's level of knowledge on the question. This table shows the example corresponding to the assessment criteria *wrong answer – wrong explanation* and '0 points'.

Table 7. Example of concept cartoons question regarding the assessment criteria 'wrong answer-wrong explanation' and results of the analysis



Which of the student(s) above do you agree with? Gorkem ☐ Ertug ☐ Dilara☐ → Wrong answer-Wrong explanation
Please explain why you think that with? "*Because the tree with light green leaves reflects less light backwards.*"

Which of the student(s) above do you agree with? Gorkem ☐ Ertug ☐ Dilara ☐ → Wrong answer-Wrong explanation
Please explain why you think that with? "*It doesn't depend on whether leaves are light dark green for the occurrence of photosynthesis. The same rate of photosynthesis occurs on light and dark green leaves.*

	0*	1	1	2	2	3
2nd Grade	54	4	1	2	25	26
3rd Grade	12	0	3	0	10	9
4th Grade	17	0	4	0	11	14
Total	83	4	8	2	46	49

The character 'Ertug', who says that the event of photosynthesis happens faster on dark green leaves than light green ones, is correct. However, the Gorkem character, who says the event of photosynthesis, is faster in light green leaves than the dark green ones and the Dilara character, who says it happens at the same speed on light and dark green leaves, are wrong. Regarding this question, which was wrongly marked and explained by 83 teacher candidates, the answers of two teacher candidates are as shown on the side.

4. Conclusion and Discussion

In the study conducted, the concept cartoons used as assessment and evaluation tools were assessed by means of a scoring key composed of the scores of 0-1-2-3. On examination of previous written studies, it is observed that Ingec (2008) used the concept cartoons as an assessment tool in his study on physics education. The researcher assessed the concept cartoons by giving "2 points" to the ones who "agree with the correct character and explain his/her decision correctly", "1 point" to the ones who "agree with the correct character but cannot explain the

reason" and "0 points" to the ones who "agree with the wrong character or leave the answer sheet blank". In the study by Şaşmaz-Ören (2009), a rating scoring key was developed in order to assess the concept cartoons prepared by the students. The researcher has ranked the evaluation levels of the concept cartoons of notions as: "performance with significant deficits (1 point)", "limited performance to be developed (2 points)", "successful performance (3 points)" and "perfect performance (4 points)". It can be argued that there are not enough written studies regarding the grading concept cartoons as an alternative measurement and evaluation medium, and regarding the analysis with scoring keys. It is thought that this study, which was conducted on the issue of analysing the concept cartoons by means of scoring key, and where the scoring key developed by Ormancı and Şaşmaz-Ören (2010) will contribute to literature in this aspects. Also, in the aforementioned study, performed in order to evaluate notion concept cartoons with scoring keys, there are samples covering the analysis process regarding each evaluation criterion. In the mentioned samples, the teacher candidates get definite points according to the answers they give to the first and second parts of the cartoon. I.e. the first part of the cartoon is answered correctly in Table 5, but in the second part, the explanation part, a wrong sample is provided. As a result, the teacher candidates get definite points regarding the answers and explanations they give for both parts of the cartoons; regarding the photosynthesis and respiration of plants. In this context, it is thought that the study, containing analysis samples regarding the utilization of concept cartoons for evaluation purposes, will constitute an example for researchers in this field. When previous literature in this field is examined, it can be argued that no other study has similar features to that of this study, but that there are studies regarding the utilization of concept cartoons as evaluation media for different purposes. İngeç, Güzel & Karakaya (2008) have used concept cartoons and notion maps and used a scoring key for the evaluation of the concept cartoons, consisting of the points 0-1-2 for the explanation of the notions heat/temperature, which they performed with candidate physics teachers. And Sexton (2010) used in his study, a query consisting of two concept cartoons in order to determine the beliefs of teachers and students regarding their preferred mathematic learning-teaching approaches. Keogh, Naylor, de Boo & Feasey (1999) have used concept cartoons as an inspection media for the education of teachers about their work. In addition, Huang, Liu & Lin (2006) have developed a two-level online test for primary education students regarding magnetism with concept cartoons. As a result, it can be concluded that there are not enough performed studies in scientific literature regarding the utilization of concept cartoons for evaluation purposes.

In line with the results obtained from the study, it can be implied that concept cartoons are applicable as alternative assessment-evaluation tools and the analysis method performed in the study through the scoring criteria and the scoring process of the cartoons are systematic and easy. In this respect, it can be suggested that studies regarding the assessment and scoring of concept cartoons and developing different assessment analysis within this frame should be conducted. With regards to the usage of a scoring key in the study, different reliability studies apart from using the agreement ratio as an evidence of reliability, which can also be accepted as the limitation of this study, should be made. Moreover, by preparing concept cartoons for various science and technology subjects, the effect of these on the level of student knowledge can be examined. In addition, it can also be suggested that teachers and teacher candidates be informed about scoring and use of the concept cartoons and offered some activity ideas in their analysis process.

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